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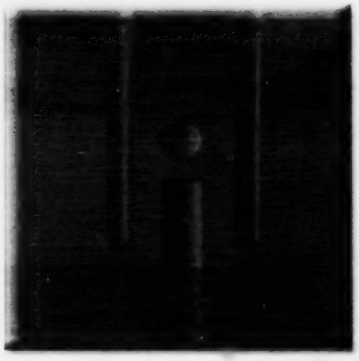
The Canadian Productivity Review

Productivity: What Is It? How Is It Measured? What Has Canada's Performance Been?



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Statistics Canada
Micro-economic Analysis Division

Productivity: What Is It? How Is It Measured? What Has Canada's Performance Been?

John R. Baldwin and Wulong Gu

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Abstract

This paper provides an overview of the productivity program at Statistics Canada and a brief description of Canada's productivity performance. The paper defines productivity and the various measures that are used to investigate different aspects of productivity growth. It describes the difference between partial productivity measures (such as labour productivity) and a more complete measure (multifactor productivity) and the advantages and disadvantages of each. The paper explains why productivity is important. It outlines how productivity growth fits into the growth accounting framework and how this framework is used to examine the various sources of economic growth. The paper briefly discusses the challenges that face statisticians in measuring productivity growth. It also provides an overview of Canada's long-term productivity performance and compares Canada to the United States—both in terms of productivity levels and productivity growth rates.

Keywords: productivity growth, Canada–United States productivity levels, terms of trade effects

Introduction

The productivity program at Statistics Canada produces a range of summary statistics on productivity and an industry database containing outputs and inputs. This product is accompanied by analysis that provides the public with an understanding of the portfolio of products and background issues.

What is productivity?

Productivity measures the efficiency with which an economy transforms inputs into outputs. Statistics Canada produces summary statistics to capture various aspects of this process.

The least complex are partial measures of productivity—that consider a single input like labour or capital. Labour productivity is measured as gross domestic product (GDP) per hour worked. Capital productivity is measured as GDP per unit of capital.

More complex measures take into account more than one input simultaneously—for example, labour and capital taken together. These are called multifactor productivity (MFP) measures and are measured as GDP per unit of a combined bundle of labour and capital.

MFP measures were devised to allow analysis of the underlying changes in the economy—to allow analysts to better understand the forces that are driving growth than simple partial measures provide. For example, understanding the growth process requires that we understand the sources of labour productivity growth.

Growth in labour productivity is intrinsically of interest because of its close relationship over time with changes in real labour compensation. Of interest is the cause of that growth. Growth in labour productivity may come from applying more capital (machinery and equipment, structures) to the production process or from technological change. And to the extent that the sources of growth from these two sources can be decoupled, the effect of policies that affect these two differentially can be evaluated. MFP measures are used to do just this.

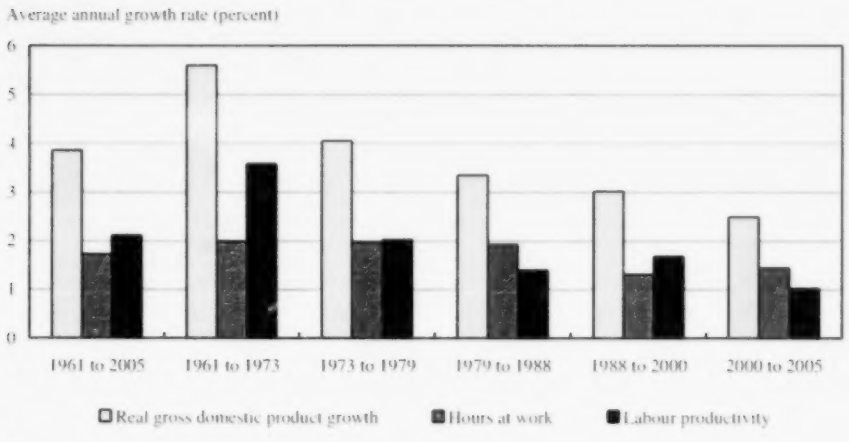
Productivity can be measured either in level or growth terms—as is GDP. But as with GDP, most attention is focused on productivity growth—and a great deal of attention is devoted to comparisons of productivity growth across countries.

Why is productivity growth important?[1]

Productivity growth is closely related to growth in our standards of living. Output growth must come either from growth in inputs and/or from growth in productivity. Indeed, this is the principle that underlies the basic method of estimating productivity growth. Productivity growth is the growth in output in excess of that of inputs, like labour.

Figure 1 contains the average annual growth of real gross domestic product (GDP) in the business sector[2] over the 1961-to-2005 period and its various sub-periods, reflecting different economic cycles. Over the whole period, economic growth increased at 3.9% per year on average. Economic growth was quite high during the 1960s, averaging 5.6% annually. Beginning in the 1970s, economic growth has experienced a steady slowdown, from 4.1% during the 1970s, down to 3.3% in the 1980s and 3.0% in the 1990s.

Figure 1
Trend in real gross domestic product, labour productivity and hours at work, business sector



Source: Statistics Canada.

Output growth can be driven by the increase in the resources devoted to production or the efficiency with which these resources are employed. Consider the case of labour input. Output will increase if there are more total hours worked or if workers produce more per hour worked (if labour productivity goes up):

$$GDP = (GDP / Hours) * (Hours) \qquad (1)$$

where *Hours* is the total number of worker-hours.

1. For a more extensive discussion of the issues in this section, see Statistics Canada 2007b.
2. The business sector is the total economy excluding non-commercial activities and the owner-occupied proportion of residential housing.

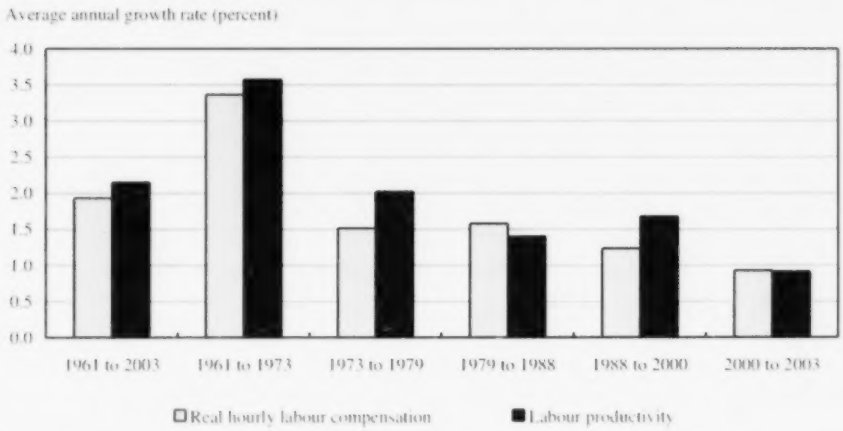
Figure 1 depicts changes in each of these components over time. For the entire 1961-to-2005 period, labour productivity advanced at a 2.1% annual average, accounting for slightly more than half of the increase in GDP growth. The rest is attributed to hours which increased at 1.7% per year on average.

Aggregate GDP measures the returns to both labour and capital. Distributional concerns lead to questions about whether the share going to labour increases over time and, in particular, how productivity growth is related to real income.

It is often claimed that productivity growth raises living standards. But how does this actually come about? The most direct way in which productivity improvements benefit people is by raising their real incomes. If higher productivity means lower costs and these savings are passed on in lower prices, consumers will be able to purchase goods and services at lower cost. The increased spending that these higher real incomes allow produces flow-on effects throughout the economy.

To see the relationship, Figure 2 compares the trend in labour productivity and real hourly labour compensation over time.[3] The picture that emerges from Figure 2 is that real hourly labour compensation and labour productivity are closely related in the long run. Most of the increase in productivity was passed through to an increase in real hourly labour compensation during the 1960s, 1970s, 1980s and 1990s.[4] The deterioration in labour productivity over time translated into a slowdown in the growth in real hourly labour compensation.

Figure 2
Growth in labour productivity and real compensation, business sector



Source: Statistics Canada.

3. Real hourly labour compensation is derived from the System of National Accounts concept of labour compensation divided by the gross domestic product implicit price deflator for the business sector.
4. See also Baldwin, Durand and Hosein 2001 for a study on how productivity growth at the industry level is passed on to product prices.

Where does the growth in labour productivity come from?

Since increases in labour productivity are associated with higher economic growth, higher standards of living and higher real incomes, analysts have investigated the sources of improvements in labour productivity.

There are many reasons behind the growth in labour productivity—increases in the amount of machines and equipment available to workers, a higher proportion of skilled workers, increases in plant scale, changes in organizational structure, and improvements in technology.

Using the growth accounting framework that has been adopted by the Organisation of Economic Co-operation and Development in its recommendations regarding productivity measurement,[5] the Canadian Productivity Accounts can be used to divide labour productivity growth into the part coming from increases in capital intensity, increases in skill levels of workers (referred to here as a change in labour composition)[6] and from all other sources—what is referred to as multifactor productivity (MFP) growth:

$$\Delta GDP / Hours = (\Delta MFP) + S_K \cdot \Delta(Capital / Hours) + S_L \cdot \Delta LC \,, \qquad (2)$$

where $\Delta GDP / Hours$ is the growth in labour productivity, ΔMFP is the growth in multifactor productivity, S_K is the share of gross domestic product (GDP) accruing to capital, $\Delta(Capital / Hours)$ is the growth in the amount of capital (machines, buildings and engineering structures) available per hour worked, S_L is the share of GDP accruing to labour, and ΔLC is the growth in the measure of labour skills.[7]

Labour productivity can grow as a result of higher capital intensity per worker. For example, stronger investment in information technology can raise capital intensity. As information technology has become less expensive, firms have substituted information technology for labour and other forms of capital.

Labour productivity can grow also as a result of a higher proportion of skilled workers. Upgrading workers' skills via education or via increased experience can increase labour productivity. Canadian companies can upgrade their workers' skills through formal schooling, on-the-job experience or retraining.

MFP captures all other effects. It is the residual factor capturing a host of influences—amongst them, changes in technology.

We have used this framework to decompose the growth in labour productivity into the proportions that come from increases in capital intensity, labour skill levels and MFP (Figure 3).

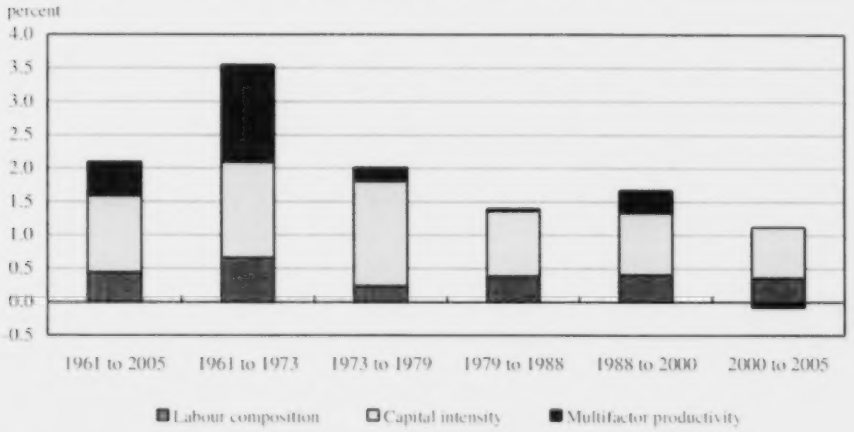
5. See http/www.oecd.org/dataoecd/59/29/2352458.pdf.

6. See Gu et al. 2003.

7. For a discussion of the growth accounting framework used to generate this formula, see Baldwin and Gu 2007b.

Over the period from 1961 to 2005, increases in capital intensity contributed to 1.1% of the 2.1% increase in labour productivity, higher labour skills to 0.4%, and MFP, 0.5%.

Figure 3
Sources of labour productivity growth, business sector



Source: Statistics Canada.

The deterioration in labour productivity growth from the 1960s to the 1970s resulted primarily from the slowdown in MFP growth from 1.5% to 0.2%, and to a lesser extent, a slowdown in the growth in labour composition due to a slower growth in skilled labour (from 0.7% to 0.2%). The contribution made by capital intensity increased from 1.4% to 1.6%.

The slowdown in labour productivity from the 1970s to the 1980s, from 2.0% down to 1.4%, was primarily the result of a decline in the growth in capital intensity and, to a lesser extent, to a decline in MFP performance.

Labour productivity performance in the 1990s reflected a turnaround in MFP growth. The contributions of capital intensity and labour composition were virtually unchanged since the 1980s.

The post-2000 period has seen a further decline in labour productivity growth. This decline is due to a decline in the growth of capital intensity and a much larger decline in MFP growth.[8] The decline in MFP growth accounted for 65% of the decline in labour productivity growth from the 1988-to-2000 period to the 2000-to-2005 period. The decline in capital intensity accounted for 27% of the decline.

8. See Statistics Canada 2007d.

What are the problems in producing summary productivity statistics?

a) With the concepts?

The Canadian Productivity Accounts produce several different measures of productivity growth. While partial productivity measures are relatively simple to understand, they have been surpassed in the world of practical analysis by the more complex multifactor productivity (MFP) measure. While this has now become the standard among experts,[9] the MFP is an analytic construct and is derived using specific assumptions regarding the nature of the economy. Being an analytic construct, the concept of multifactor productivity is more difficult for the less expert users of Statistics Canada's products to understand. And the assumptions embedded in the growth accounting framework mean that its validity in the eyes of some users relies on the acceptance of these assumptions.

The Canadian Productivity Accounts have responded to these issues by providing detailed descriptions of the methodology used in developing the measures,[10] and examining the extent to which alternate approaches yield significantly different measures of MFP growth.[11]

The second major problem with multifactor productivity estimates is that they capture what we cannot explain: they are a residual calculated after other measurable factors have been taken into account. To some analysts, this is not a problem since they want a measure of the externalities that are bestowed on an economy by disembodied technological progress. But even here, guidance is needed on what the underlying factors might be that are behind this component—changes in plant scale or production run length economies, firm reorganizations relating to offshoring and outsourcing, new technologies, intangible capital. To meet demands in this area, Statistics Canada has responded with studies using business microdata in each of these areas.[12]

b) With measurement?

In an economy as large and diverse as that of Canada, it is a Herculean task to calculate a summary statistic for productivity that, in 2005, sums up the efforts of 16.2 million workers, employed in thousands of establishments that produce about $1.4 trillion in output. Statistics Canada does so in its productivity program, which uses an integrated set of data sources produced by the System of National Accounts.

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9. See *Economist* 2004.
10. See *Productivity Growth in Canada*, Catalogue no. 15-204, and the various publications in the series *Canadian Productivity Review*, Catalogue no. 15-206.
11. Baldwin, Gaudreault and Harchaoui 2001 examine the use of parametric as opposed to non-parametric techniques. Baldwin and Gu 2007a examine the impact of using alternate techniques of estimating the cost of capital when deriving estimates of capital services. Statistics Canada 2007c examines the impact of alternate depreciation rates.
12. These papers can be found in the Economic Analysis (EA) Research Paper Series, the Analytical Studies Branch Research Paper Series and The Canadian Productivity Review, and are summarized in the Update on Economic Analysis section on Statistics Canada's website.

Statistics Canada produces productivity statistics as part of a regular production program. It is not something done as in many other countries, as an occasional research exercise. The production process for the Canadian Productivity Accounts is embedded within the System of National Accounts. The Canadian Productivity Accounts play an important role as an integrator of data from different sources within the agency.

Statistics Canada's integrated national accounts provide the foundations on which the productivity accounts are based. Because they are integrated across several dimensions—from the demand side, from the income side and from the industry accounts—along with detailed input–output tables, there is a solid foundation on which the productivity accounts builds. For example, estimates of productivity using the demand side are reconcilable to those coming from the industry side.

The Canadian Productivity Accounts puts together an integrated set of data on outputs, inputs, labour and capital contributions to the production process. Statistics Canada's Productivity Accounts build first off an integrated set of production accounts—that generate gross domestic product from final demand, and at the industry level with one set of integrated, coherent accounts. The Productivity Group takes this integrated set of accounts and produces a set of estimates of labour services and capital services that are coherent with the output estimates. For example, on the labour side, the Productivity Group chooses amongst various source data (there are multiples sources, i.e. household versus employer surveys, each giving different estimates of labour inputs), ensures the boundaries of the labour sources agree with the boundaries of the industry data, and produces a set of labour inputs (by estimating jobs and hours-worked separately and then multiplying them together). In the case of capital services, the Group takes investment data from a survey of investment, reconciles and modifies them to accord with System of National Accounts boundaries, and then estimates capital services making use of rates of return that are derived from the System of National Accounts estimates of profits or surplus taken from the input–output tables.

Statistics Canada's productivity program also provides quality assurance across all input sources by improving the overall coherence of these products. Analysis in the productivity program, as is the case elsewhere in the National Accounts, is an extension of the particular nature of the production process. The production process in the Canadian Productivity Accounts combines data from different sources. To construct official data series, this production process confronts data from one source (for example industry value added) with data from another (for example, labour inputs). In the end, this comparative process serves to bring a variety of sources into coherence with one another. Data that are generated from production surveys are subject to both response and non-response errors. By examining how one series compares to another (for example, how employment estimates from the Labour Force Survey compare with those from the Survey of Employment, Payroll and Hours), analysts in the Productivity Accounts can assess whether the survey error in one or the other data source is particularly large in one period and adapt the estimate that is most appropriate for the creation of a time series that is not only consistent over time but is also coherent with the other data that are being used in the estimates of productivity.

The Productivity Accounts develops and maintains a large database in support of the productivity program—what some refer to as the KLEMS (Capital, Labour, Energy, Materials and Services) database. KLEMS integrates time series data on gross output, materials inputs, service inputs, energy purchases, labour, investment and capital. Each of these data series is calculated in both nominal dollars and real (constant) dollars. Price indices are collected for each of these series. Finally, KLEMS classifies these series using four different levels of aggregation—corresponding to the S, M and L levels used in Statistics Canada's Input–Output Accounts.

Areas for improvement

While the Canadian Productivity Accounts has one of the better System of National Accounts programs in the world on which to build, there are several areas where improvements can be made.

First, estimates of growth in real output require estimates of price deflators. All statistical systems evolve by adjusting to user demand. The System of National Accounts is generally superior when it comes to producing estimates of output in current dollars than they are for producing estimates of volume growth because the latter require price indices for a very broad range of a constantly changing bundle of products. The System of National Accounts estimates almost 30% of output in the business (market) sector in ways that merit improvement.[13]

The System of National Accounts has progressed considerably in this area and continues to make progress within constrained budgets. In particular, the Services Price Initiative has begun to produce new more accurate measures of prices in areas where it had no estimates (and where input prices were used as proxies) and in those areas where changes in the economy (deregulation of airline and communications industries) were producing price changes that required new collection procedures.

The problems of measuring growth in real output are particularly severe when it comes to measuring real output in the government and non-market sector. Generally, where market transactions are not available to measure revenues, output is measured by payments to factors in the non-market sector. Input prices are used to deflate this measure—which yields, by construction, zero productivity growth. Because of this, the Productivity Accounts focus most of their attention on only the market or business sector—despite the demand from the user community for more comprehensive estimates.[14]

Second, users of productivity growth estimates need to take into account potential problems with the concepts used by the international system of national accounts to measure output of particular sectors. Deficiencies in both the banking and insurance sectors have received considerable

13. This includes the finance sector and industries where implicit prices using inputs (i.e., labour) have been employed.

14. Estimates of total economy are produced in occasional publications as a result of special user requests—often for international comparisons when comparable estimates of the business sector are not readily available for other countries.

attention from the user community.[15] Other industries that have received attention are the resources sector and the measurement of real output associated with exploration activity in natural resource industries. The latter is particularly important to the resource sector of the Canadian economy.

Third, consideration needs to be given to whether the list of inputs used in the estimate of multifactor productivity (MFP) is sufficiently comprehensive. For example, the estimates of capital focus primarily on physical capital—machinery and equipment, buildings, and engineering structures. Recent work in the academic community has suggested that intangible assets (one of which is research and development) have become increasingly important and need to be considered if we are to better understand the growth process. Similarly, estimates of MFP in the business sector generally ignore the impact of public infrastructure.

International productivity comparisons

Data that may be fit for one purpose—that meet acceptable quality standards in one area—may not be for others. And statistics may be developed for one purpose but users may begin to employ them for other purposes—for which they were not designed and for which they may be less than ideal.

The evolution of the Canadian productivity program provides an example of just such a transition. Statistics Canada's productivity accounts were originally developed to provide information on productivity *growth rates* in Canada—first with regards to labour productivity and then to multifactor (what academics often refer to as total factor) productivity. In a world of increasing globalization, demands of users for international comparisons have increased. Providing estimates for international comparisons that meet acceptable quality standards poses particular challenges.

The productivity program at Statistics Canada first focused on providing information products that compare Canada–United States productivity *growth* rates, choosing U.S. estimates that are closest to the Canadian ones. Despite differences between the two countries in sources used, these differences are sufficiently stable over time that they generally do not provide a major problem for comparisons of Canada–United States *growth* rates.

But the summary statistics produced by the official productivity programs of the two countries turn out to be less than ideal for analysing differences in productivity levels. Analysts have used data that are employed in the growth programs to generate cross-country comparisons of levels.

While the data that were being used for this purpose were not generated for purposes of estimating differences in levels, statistical agencies have to respond to users needs since *relevance* is an important aspect of quality of product.

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15. See Triplet and Bosworth 2004.

In Canada, users have requested guidance on the quality of Canada–United States productivity comparisons. Recently, Statistics Canada commenced a set of studies that examined alternatives that can be used to estimate the level of relative productivity—both labour and multifactor productivity. Statistics Canada found that despite the relative similarity in the statistical systems of the two countries, improved harmonization of data sources and methodology was required in order to produce better estimates of the relative level of Canada–United States productivity.

Our studies here pointed out several problems with many previous attempts to compare Canada–United States levels of labour productivity.[16] First, studies were sometimes not using measures of gross domestic product (GDP) that were comparable. GDP is measured at market prices, at basic prices and at factor cost. And the level of GDP that is produced by these estimates can vary by up to 16%. Secondly, comparisons of levels of GDP across countries need to take into account differences in price levels if relative values of output are to be transformed into relative levels of real output. For this purpose, purchasing power parities (PPPs) are necessary and the existing PPPs are sufficiently imprecise as to produce estimates of relative levels of output with quite large confidence intervals around them. Finally, and most importantly, obtaining accurate estimates of relative labour input provide particular challenges. Differences exist in the way that labour input is calculated in the official productivity programs of both countries that have led to a substantial downward bias in the relative Canadian level of labour productivity when it is derived from the 'official' sources of labour productivity from each country. The estimate of total hours worked comes from the product of number of jobs multiplied by hours worked per job. The estimate of hours worked per job that is derived from a labour force (household) survey is generally higher than that derived from an employer survey. The Canadian productivity program relies on the former while the U.S. productivity program relies on the latter. When comparable sources are used for both countries (whether they be household or employer surveys) in both countries, the relative labour intensity in Canada increases by between 5% and 10% relative to the estimate derived from each country's official estimates used in the productivity growth programs.

Canada–United States levels

The debate about Canada's productivity gap often revolves around its contribution to a gross domestic product (GDP) per capita gap. GDP per capita differences between Canada and the United States can be examined using the following identity:

$$GDP / POP = (GDP / HRS) * (HRS / EMP) * (EMP / POP) . \quad (3)$$

This identity decomposes relative GDP per capita (*GDPCAP*) into the product of relative labour productivity (*GDP / HRS*), relative effort (the hours worked per job [or per employee]), and the relative per capita employment rate (the ratio of the number of employees [or jobs] to the total population). The equation can be rewritten in the following manner:

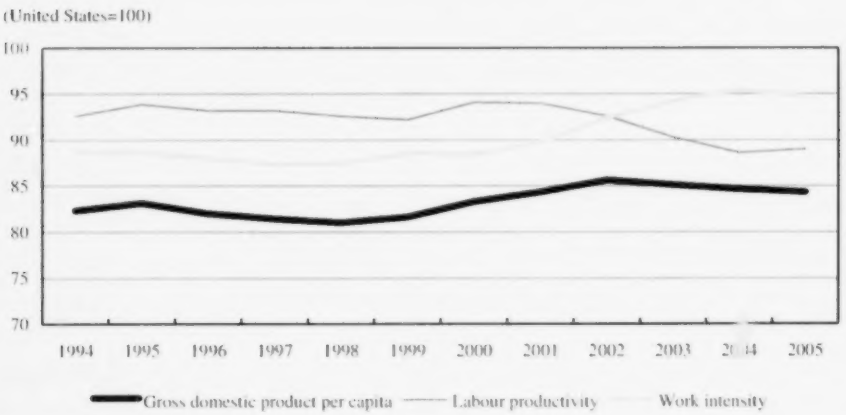
$$GDPCAP = PROD * EFFORT * EMPRATE . \quad (4)$$

16. See Baldwin et al. 2005 and Maynard 2007b.

The amount available for consumption per person in a country (GDPCAP) will be higher when productivity (*PROD*) is higher, when employees work longer hours (what is referred to here as *EFFORT*), and when a larger proportion of the population is employed (*EMPRATE*). The variables *EFFORT* and *EMPRATE* can also be grouped together in a variable that captures the number of hours worked per capita.

Over the period from 1994 to 2005, the level of GDP per capita in Canada averaged only 83.2% of GDP per capita in the United States (Figure 4). In other words, the output gap in favour of the United States was 16.8% in terms of GDP per capita. But the gap between Canada and the United States in labour productivity was much less—at only 7.8% of the U.S. productivity level. This means that the average difference in labour productivity over this period accounted for 45% of the total percentage-point difference in the GDP per capita of the two countries. That is, if work intensity was the same in the two countries, more than half of the difference in GDP per capita would disappear. Over this period, hours worked per capita in Canada were only 90.3% of the hours worked per capita in the United States.

Figure 4
Canada–United States relative gross domestic product per capita, labour productivity, and work intensity, for the total economy



Sources: Statistics Canada; Bureau of Economic Analysis.

When this variable is decomposed into the three components mentioned above, substantial differences between Canada and the United States can be found in each of the two former areas. Over the period from 1994 to 2005, hours worked per job in Canada was only 95.1% of hours worked per job in the United States. Jobs per potential member of the labour force (population older than 15) in Canada averaged 92.4% of the U.S. job rate. The relative Canada–United States labour force ratios—the number of individuals who are older than 15 divided by the total population—averaged 102.8% over the entire period. This reflects the fact that the population is older on average in Canada than in the United States. This ratio has continuously increased over time, moving from 101.9% in 1994 to 104.0% in 2005.

Levels of multifactor productivity

If we wish to understand the factors that drive differences in labour productivity between Canada and the United States, additional work is required to derive estimates of inputs other than labour. The most important for transforming relative labour productivity into relative multifactor productivity (MPF) is an estimate of relative capital intensity. Once again, data sources and methodology in Canada and the United States need to be harmonized. Perhaps the most important choice here is that of depreciation estimates—since capital is estimated as the sum of past investments less the depreciation that has taken place.

Canada and the United States do not use exactly the same depreciation estimates—though they both make use of used asset prices to estimate the rate at which investments in new assets decline in value (i.e., depreciate) over time. Canada has a comprehensive set of price data that is associated with its investment survey. The United States makes use of a myriad of sources (trade data) to estimate its depreciation rates. The resulting estimates for Canada and the United States differ slightly for machinery and equipment and more for buildings and engineering structures.[17]

There are differences between Canada and the United States in the importance of different types of physical capital. Despite the attention that is paid to machinery and equipment, it accounts for no more than 25% of total capital in Canada in 1999. In contrast, buildings account for over 55%.

Large amounts of capital are also devoted to engineering construction in Canada. In fact, at 20%, the share of engineering construction is almost as large as that of machinery and equipment. These assets underpin the utilities sector, pipelines, railways, airports, communications, and the oil and gas sector.

As previously discussed, capital stocks in both countries are the accumulation of these investments over time that are summed using the perpetual inventory method. However, if different services lives and different depreciation rates are used to compare Canada and the United States, the relative level and trend may be distorted. Thus, previous comparisons of capital intensity between Canada and the United States using unadjusted depreciation rates may partly reflect different methodologies. Depreciation rates in the United States that are used by the Bureau of Economic Analysis (BEA) are sometimes lower than those used in the Canadian productivity program, particularly in engineering structures and building structures.

Differences in the ratio of capital to gross domestic product (GDP) are provided in Figure 5 using the depreciation rate of Statistics Canada, that of the Bureau of Economic Analysis, and that based on the each country's respective depreciation rates. The line labelled 'Own' depicts the course of the total capital-to-GDP ratio if we employ the productivity estimate from the Canadian productivity program and the BEA productivity program. Figure 5 also contains the capital–output ratios using common depreciation rates (either Canadian or U.S. rates) to produce capital stocks for both countries. Using common rates raises Canada's relative capital intensity.

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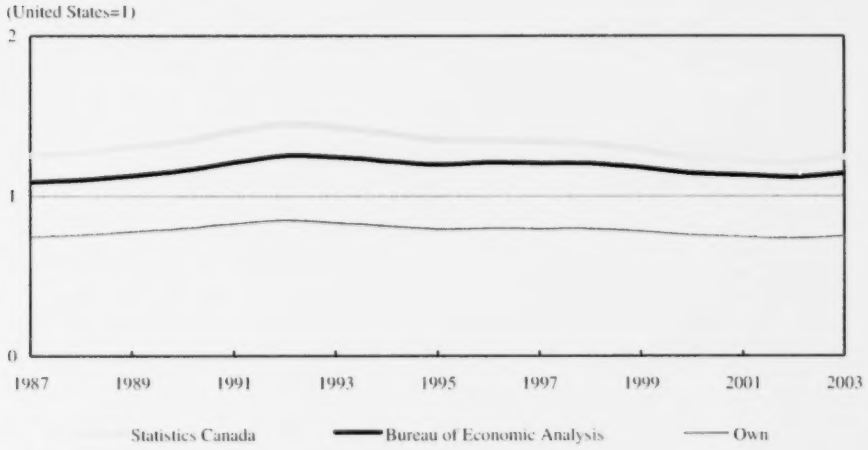
17. Canada also has estimates of expected length of life that it uses to confirm the estimates it derives from used asset price data. See Statistics Canada 2007c.

We first apply BEA depreciation rates to the Canadian stock and compare capital intensities between the two countries. Based on common BEA depreciation rates, Canada's relative capital intensity becomes higher than that based on 'own' depreciation rates. To undertake a sensitivity analysis, we also apply Statistics Canada's depreciation rates used in its productivity program to BEA capital stocks. Interestingly, Canada's relative capital intensity rises further with Statistics Canada's depreciation rates.[18] Thus, the magnitude of the difference between Canada's capital intensity and the U.S. capital intensity is also sensitive to the choice between BEA and Statistics Canada depreciation rates. But at least in the latter part of the 1990s, there is not much difference between the two curves—and the difference is not statistically significant.

Figure 5
Canada's total capital stock intensity relative to the United States, business sector (in 1997 dollars)



Sources: Statistics Canada; Bureau of Economic Analysis.

However, an examination of capital-to-GDP ratios by asset class reveals substantial differences (Figure 6). Canada's engineering capital-to-GDP ratio is higher than that of the United States and has been growing relatively larger over time.[19] Building capital intensity is slightly higher in the early 1990s but has fallen behind recently. Machinery and equipment was about the same in the early 1990s but it too has fallen slightly behind.

The evidence on relative capital intensity can be used to generate a measure of the relative value of capital services and then, combined with the level of relative labour productivity, to generate a measure of the relative MFP in Canada as opposed to the United States (see Table 1). The aggregate level of MFP in the Canadian business sector economy was 80.3% that of the United States in 1999. The aggregate level of labour productivity in Canada was 84.2%.

18. These results apply to all asset types in both 1997 and current dollars.

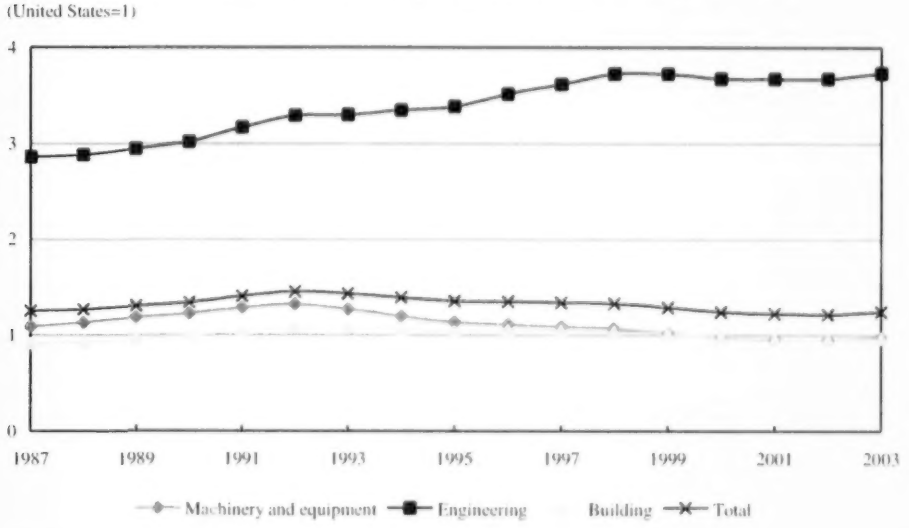
19. This trend has been occurring for a long time. Baldwin and Gorecki 1986 report that in manufacturing the Canada/U.S. ratio of machinery and equipment was relatively stable between 1961 and 1979 but structures and engineering increased in relative terms.

Table 1
Relative Canada–United States productivity levels for the business sector

Business sector	1999
	percent
Labour productivity levels	84.2
Multifactor productivity levels	80.3

Sources: Statistics Canada; Bureau of Economic Analysis.

Figure 6
Canada's total capital stock intensity relative to the United States, business sector, using Statistics Canada's depreciation rates (in 1997 dollars)



Sources: Statistics Canada; Bureau of Economic Analysis.

We have decomposed labour productivity differences between Canada and the United States into contributions of MFP and capital intensity (Table 2). MFP and machinery and equipment (M&E) were the main contributors to the lower level of labour productivity in Canada relative to that in the United States. The ratio of buildings and engineering structure capital to labour was higher in Canada, reducing the gap in the relative level of Canadian labour productivity. The results (Table 2) show that the aggregate level of labour productivity in the Canadian business sector was 15.8% behind that of the United States in 1999. The lower level of MFP in Canada lowered the relative level of labour productivity in Canada by 19.7%. The lower level of the M&E capital–labour ratio lowered the relative labour productivity in Canada by 3%, while the higher level of the structure capital–labour ratio increased Canadian labour productivity by 9%. Differences in MFP account for the majority of the differences in the level of labour productivity.

Table 2
Sources of Canada–United States labour productivity differences in the business sector, 1999

	Labour productivity	Contributions of		
		Multifactor productivity	Material and equipment per hour	Structure per hour
		percent		
Business sector	-15.8	-19.7	-3.0	9.0

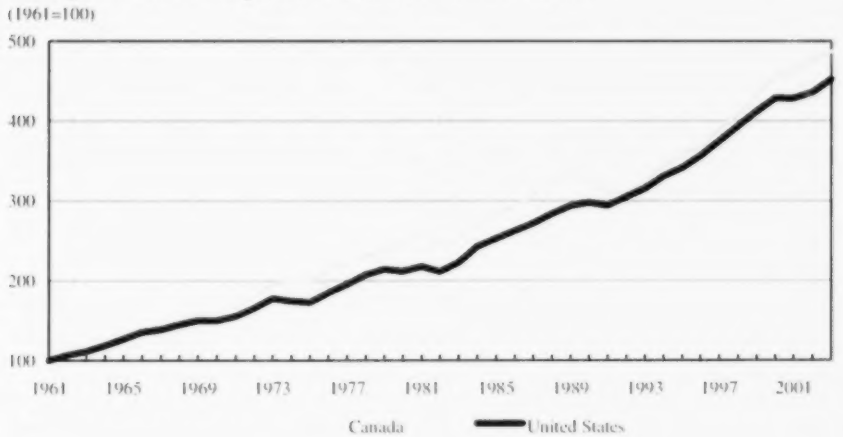
Sources: Statistics Canada; Bureau of Economic Analysis.

Long-term trends

The estimates of the level of Canada–United States productivity can be combined with long-run trends in growth rates to generate a picture of differences in the growth process in the two countries.

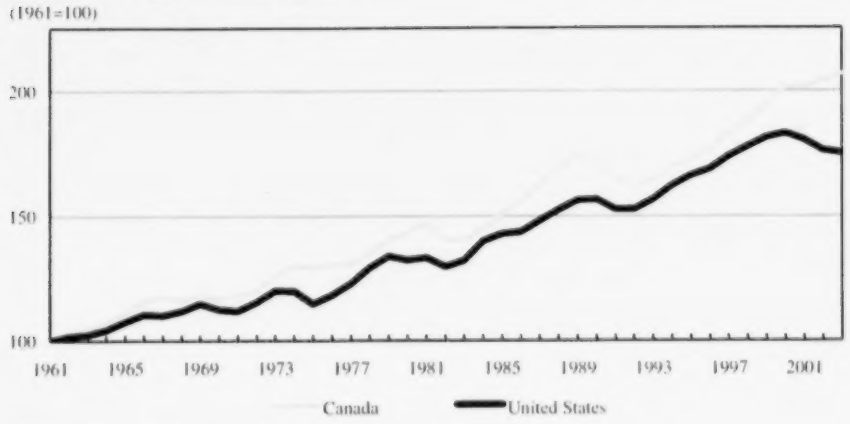
The cumulative growth in business sector gross domestic product (GDP), labour inputs and labour productivity over the post-1961 period are presented in Figures 7, 8, and 9 respectively—with 1961 being set equal to 100 in both countries.

Figure 7
Real gross domestic product trend, business sector



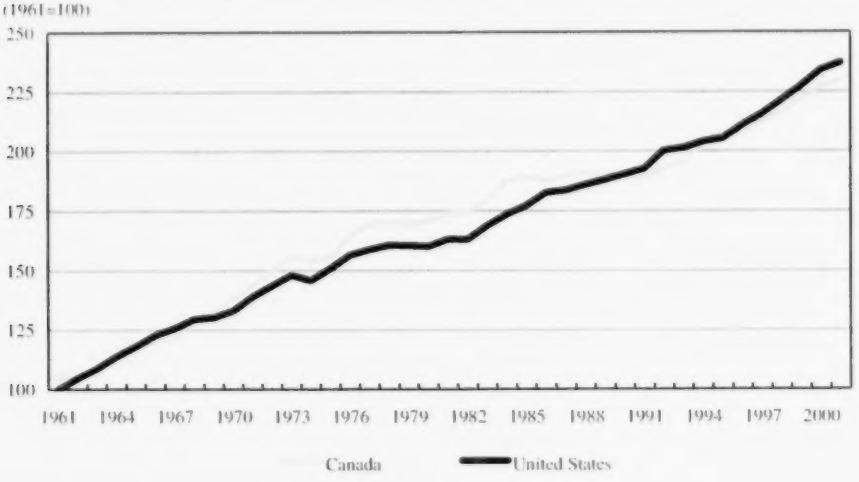
Sources: Statistics Canada; Bureau of Economic Analysis.

Figure 8
Hours at work, business sector



Sources: Statistics Canada; Bureau of Economic Analysis.

Figure 9
Labour productivity trend, business sector

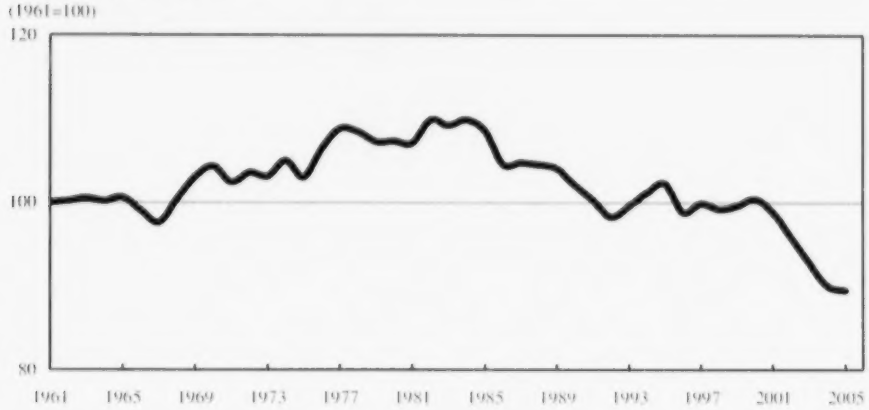


Sources: Statistics Canada; Bureau of Economic Analysis.

Canadian output growth exceeded that in the United States in the 1970s, kept up with the U.S. output growth in the 1980s, experienced a greater slowdown in the early 1990s and then broadly paced that of the United States in the 1990s (Figure 7). In contrast, labour input grew at a more rapid pace in Canada than in the United States in most decades, with the largest divergences occurring after 2000.

Labour productivity grew more quickly in Canada during the earlier period, reaching a zenith around 1985, came back to the same relative level about 1990, stayed the same throughout the 1990s, and has fallen behind since then (see Figure 10). Over the entire time period, the rate of growth in labour productivity is not significantly different—though the most recent decline is of concern in some circles.

Figure 10
Relative Canada–United States labour productivity level in the business sector, 1961 to 2005

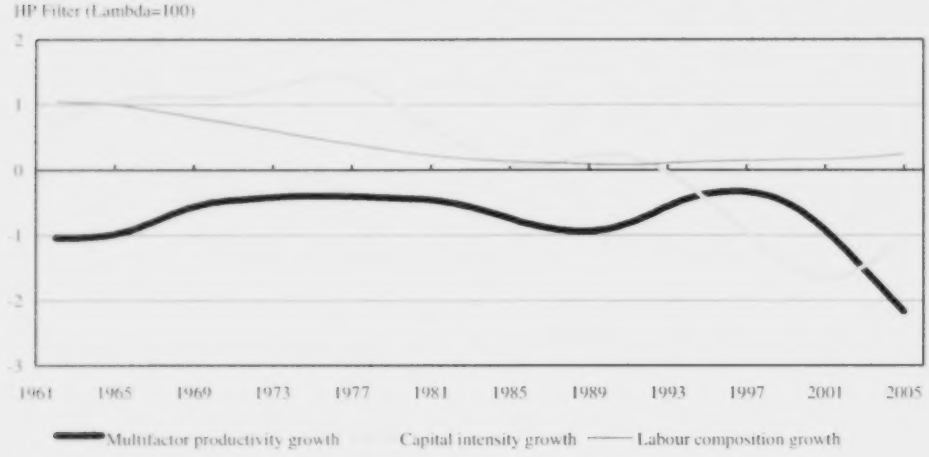


Sources: Statistics Canada; Bureau of Economic Analysis.

The differences in labour productivity performance can be decomposed within the growth accounting framework into differences in multifactor productivity (MFP) growth, differences in the growth in capital intensity, and differences in skill upgrading (what the growth accounting framework refers to as changes in the composition of labour).[20] Figure 11 tracks the relative difference in each of these components.

20. For further details, see Statistics Canada 2007a.

Figure 11
Trend in Canada–United States difference in growth of multifactor productivity, capital intensity and labour composition, business sector (in percentage points)



Sources: Statistics Canada; Bureau of Economic Analysis.

The following conclusions emerge. The Canada–United States labour productivity growth gap in favour of the United States over the period from 1961 to 2005 owes much to the MFP growth gap which existed throughout the period. Over the period from 1961 to 2005, annual labour productivity growth in the Canadian business sector was slightly, but not significantly, lower (0.2 percentage point) than in the U.S. business sector. The annual MFP growth in Canada was 0.7 percentage point lower than in the United States.

In contrast, there was no continuous investment gap in Canada over the entire period from 1961 to 1996. Indeed, early in the period, the contribution of capital deepening to business sector productivity growth was higher in Canada than in the United States; but starting in the late 1970s and early 1980s, Canada's rate of growth in capital intensity fell behind that of the United States only to see the two countries follow much the same path over the late 1980s. A significant capital intensity gap opened up in Canada after 1996. Over the period from 1996 to 2005, the slower rate of capital deepening accounted for 0.2 percentage point, or 19%, of the Canada–United States aggregate labour productivity growth gap.

The contribution of labour composition to business sector labour productivity growth was higher in Canada than in the United States over much of the period from 1961 to 2005—though the advantage declined later in the period. Over the period from 1961 to 2005, a more rapid shift towards more educated and more experienced workers occurred in Canada, which raised the labour productivity growth by 0.2 percentage point per year in the Canadian business sector relative to that of the U.S. business sector.

Setting productivity in perspective[21]

Summary statistics relating to productivity indicate how efficiently an economy is transforming its inputs into output. But they are far from comprehensive in terms of delineating how well off Canadians are.

Evaluations of an economy's productivity performance are made using a measure of real gross domestic product (GDP), which represents the constant dollar income (labour income plus profits) that an economy generates through domestic production, with the volume or constant dollar indices being calculated from the prices of domestic goods and services produced.

This measure does not account for who receives the income (domestic or foreign residents), how much capital is used up through production or how relative price shifts of exports versus imports (terms of trade) affect the volume of goods and services that can be purchased with the income.

Modifications can be made to traditional estimates of GDP to account for these factors. The performance of the Canadian economy can also be examined using the resulting alternate measures—gross domestic income (GDI), gross national income (GNI) and net national income (NNI).

When the concept of real income is widened to include changes in the purchasing power of earned income, the relevant measure is real gross domestic income (GDI). Changes in purchasing power come from changes in relative prices of exports and imports—one of which is the terms of trade.

Real GDI is a constant dollar measure of the purchasing power of income generated by domestic production in Canada, taking into account changes in the relative levels of import and export prices. However, Canadians invest abroad and foreigners invest in Canada. As a result, not all of the incomes earned in Canada accrue to Canadians, and some of the income earned in other countries is owed to Canadians. When these international income flows are combined with real GDI, the resultant real income aggregate is real gross national income (GNI).

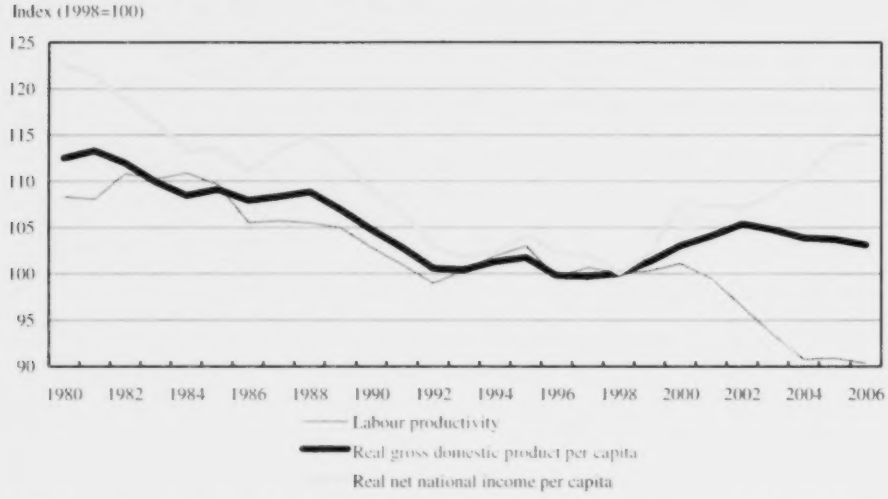
Finally, subtracting capital depreciation leads to real NNI. Real NNI captures the purchasing power of real income retained by residents of Canada after they have replaced worn out and obsolete physical capital. It is the purchasing-power-adjusted real income distributed to Canadians after ensuring the maintenance of the domestic capital stock of machinery and equipment, buildings and infrastructure.

For purposes of comparison, measures of real GDP per capita and real NNI per capita in Canada relative to the United States are presented in Figure 12. In real terms, the Canadian economy lagged behind the U.S. economy prior to 2000, as relative GDP per capita fell about 10 percentage points over the 1980s, levelled off in the 1990s and then increased slightly after 2000. Relative productivity also declined prior to 2000—falling in the 1980s, holding steady in the

21. For further discussion of this issue, see Macdonald 2007.

1990s and then declining precipitously after 2000. The difference between GDP and productivity growth after 2000 occurred because the Canadian labour market was much more buoyant than the U.S. labour market. Hours worked per capita increased more rapidly in Canada than in the United States—driven by a much larger increase in number of jobs per capita.[22]

Figure 12
Economic performance of Canada relative to the United States[1]



1. Real gross domestic product and real net national income per capita are for the economy as a whole while labour productivity is for the business sector.
Sources: Statistics Canada; Bureau of Economic Analysis.

Declining relative prices for commodities and the depreciation of the dollar take a further toll on the measure of Canadian real NNI per capita compared to the United States, leading to a more noticeable decline in real NNI during the 1980s than relative GDP. Prior to 1990, relative income falls more than relative GDP. The real income measure reveals an even greater gap in the performance of the two economies

In the period before 2002, all of the measures indicate a long-term decline in the relative performance of the Canadian economy—though the various modified income measures decline more than the relative GDP per capita measure, especially in the 1980s. These were the years in which the resource economy in Canada was in decline. Resource inputs as a percentage of GDP were falling around the world. Relative commodity prices were declining. Canadians were increasingly remitting more abroad than they were receiving. As a result, the various income measures actually declined more than the measures of GDP.

All that has changed with the commodity boom that Canada has experienced after 2000. Prices of exports have increased dramatically relative to the prices of imports. Canadian receipts of income from abroad have increased dramatically relative to payments abroad. The concatenation of these events has led to a dramatic increase in real income growth in Canada relative to its

22. See Maynard 2007a.

GDP growth. And this also has affected Canada–United States comparisons. Canada had a strong terms-of-trade improvement from 2002 to 2006, due to rising commodity prices, an appreciating currency and falling world prices for manufactured goods that contributed greatly to real income growth. The U.S. measures of real income were much less affected by trading gains.

As a result, comparisons of the relative per capita performance of the two countries hinges crucially on whether or not the terms of trade and international income flows are incorporated into the analysis. If the terms of trade are excluded, and relative real GDP per capita growth (or relative productivity growth) is the focus, Canada appears to be performing worse than the United States from 2002 to 2006. From 2002 to 2006, U.S. real GDP per capita grows 9.3% while Canadian GDP per capita rises 7.0%, making it appear that the U.S. economy is outperforming the Canadian economy. Once changes in resource prices and the exchange rate, international investment income and capital consumption are taken into account, real income per capita in the United States increases by 8.6%, which is similar to its GDP per capita growth. However, the Canadian adjusted measure of real income per capita growth rises 15.6%, more than twice the per capita real GDP growth in Canada and nearly double the U.S. rate.

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